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Research Paper

Determination of Economic Optimum Replacement Age of Oil Palm in Kogi State, Nigeria.

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Abstract: The study was conducted to determine the optimum replacement age of oil palm. The tool of analysis used was optimum replacement model. Data for the study were collected from the Nigerian Institute for Oil Palm Research, NIFOR, Oil Palm Plantation, Acharu Substation and NIFOR Headquarters, Benin City. Data collected were analysed using tool of analysis as specified. The study found that the cost of establishment of oil palm plantation was enormous, about N260,252.70 per hectare per annum. Established oil palm plantation has four (4) years of gestation period before fruiting at which time the farmer would have to wait and bear the cost. The highest or peak yield was 13.50 tons/ha. The study shows that optimum replacement age of oil was 35 years. It is recommended that there should be conscious desire at new planting or replanting of oil palm. Oil palm farmers should be encouraged to cut down their old oil palm trees at the age of 35 years.

Keywords: Oil Palm, Productivity,Determination, Optimum, Replacement Age.

Introduction

Few wild trees are of as much economic and social value to Nigeria farmers and the country as oil palm tree (Usoro, 1974). The oil palm, *Elaeis guineensis* Jacq, no doubt, is believed to have originated in the tropical rainforest region of West Africa (Agboola, 1979; Hartley, 1988; CTA, 1998). Oil palm is a monocotyledonous plant belonging to the family, Palmae and Sub-family, Cocoideae. The normal (diploid) chromosome number is 2n = 32. The Adult plant possesses an impressive crown of 30 to 45 green leaves, each 5 – 9m long at the top of a trunk bearing old leaf bases arranged spiritually (Kochhar, 1976; Opeke, 1992; CTA, 2000). The stem may be 30cm to 38cm in diameter, with progressive thickening towards the base. On older palms, the stem is punctuated with conspicuous and regularly arranged leaf scars and the stem terminates in a handsome growth of leaves (fronds).

The plant is monoecious with separate male and female flowers (inflorescences) on the same plant. Cross-fertilization is achieved through successive cycles of male and female flower production. It produces bunches of fleshly fruits, the pulp (Mesocarp) of which yields a solid, edible, orange-red oil called palm oil. The endosperm or kernel yields a clear yellowish oil that is also edible and solid and is called palm kernel oil. These two products are important in world trade.

Oil palm adapts well to most textures from medium loams to clays. Extremely coarse or fine textures may not always be suitable, especially if they affect water supply to the roots. The climatic and soil requirements constitute the physical factors that are responsible for the growth of oil palm. The include availability of water supply, soil conditions in terms of fertility and topography that is suitable for the growth of oil palm. It is recommended that rainfall of 1, 600mm to 5,000mm per year evenly distributed will enhance the growth of oil palm (Keu, 2001; Khera, 1976, Ukwuteno, 2011). The oil palm has a wide adaptability range of soils to low pH but sensitive to high pH (above 7.5) and stagnant water. Neutral pH (pH 7.0) soils are most favoured. The temperature requirement varies between 18^0C and 34^{0C}. Opeke (1992), observed that oil palm would tolerate even higher temperatures, provided there is adequate moisture. It requires plenty sunshine; productivity is reduced in areas with excessive sky over cast. It thrives under conditions of high relative humidity; yields are adversely influenced when the crop is exposed to dry harmattan winds (CTA, 2000).

Oil palm is affected by pests and diseases attack. Pests and diseases attack both seedlings in the nursery and mature plants on the field. Some notable pests of oil palm are snails, crickets and mammals especially rodents (rats and mice). Others include leaf-miners, weevils, caterpillars, birds and squirrels. The oil palm diseases include *Anthracnose*, *Freckle, Blast, Ganoderma trunk rot, vascular wilt* disease, *Basal rot* and *crown* diseases. These pests and diseases pose serious problems to the production of oil palm (Uguru, 1996; CTA, 1998).

The extensive development of oil palm industries in many countries in the tropics has been motivated by its extremely high potential productivity. The oil palm gives the highest yield of oil per unit area compared to any other oil crop. Oil palm seems to be part of the traditional agriculture of Kogi State, Nigeira. The climatic condition and soil type of Kogi State appear favourable for the growth of oil palm.

Oil palm is rich in palm oil, having higher yield of oil than any other oil seeds. The processing of oil palm fruits for edible oil has been practiced in Africa for thousand of years, and the oil produced, highly coloured and flavoured is essential ingredient in much of the traditional West African cuisine (USDA, 2000). The traditional processing is simple but tedious and inefficient.

The widespread acceptance of palm oil as cooking and industrial oil means higher demand for the product than other oils. Besides, the presence of carotenoid in palm oil makes it very valuable. Carotene is a precursor for vitamin A, which is very vital for the remedy of night blindness (NRDC, 2003). Palm oil is used in the homes as cooking oil. In industries, it is used for the manufacture of magarine, soap, lubricating oils and candles. Palm kernel oil is used as skin lotion or as laxative, when mixed with kerosene, it is used as a wood polish. After extracting the oil, the residue, the palm kernel cake, forms an excellent animal feed. Palm wine obtained by tapping the tree is used as a very good source of alcoholic drink in many social gatherings in Nigeria. Both the oil and wine obtained from oil palm have medicinal value.

Oil palm provided large quantity of palm oil and palm kernels, which in the 1960s accounted for 43 percent of the world production. Today, it only accounts for 7 percent of total global output (WRM, 2001). The declining productivity and production of

oil palm over the years make it necessary to carry out an in-depth investigation. The share of oil palm contribution to Gross National Product (GNP) has equally suffered a setback. Ibe and Nweke (1985), estimated the production and demand for palm oil in Nigeria. The result showed that demand far exceeded the production. Again, there is currently an increase in the demand for palm oil to meet the local consumption needs. This has necessitated the importation of palm oil (WRM, 2001).

One of the major cause of the supply gap is the issue of managing over-aged palms. Old palms are usually too tall with impaired productivity. Tall palms have to be climbed which is arduous and risky. Besides, most oil palm producers have no knowledge of the optimum production period of their palms, so, they allow them to produce fruits till they die on their own. This affects the production potential of the industry. The solution to the problem of over-aged palm is to replace them with new ones.

The oil palm production curve like the general production curve (fig.1) satisfies the law of diminishing marginal product. The marginal physical production of oil palm as it ages will eventually decline, assuming all other variables remain constant (unchanged). Four phases of production can be identified from (fig.1): (1) The phase of no yield at all. (2) The phase in which output increases at an increasing rate. (3) The phase in which output increases at a decreasing rate and (4) The phase in which the incremental output is negative. The oil palm production, as shown in fig (1), the rational phase to produce is phase (3). Having identified the rational phase, when should an oil palm producer replace his existing oil palms with new ones? In other words, when will he start losing revenue as a result of non-replacement? When is it appropriate to replace the existing oil palm trees?What is the optimum replacement age of oil palm? How can productivity of oil palm be increased in the study area?

Izeke (1983); Kheloa and Nnawe (2007), used optimum replacement model in order to arrive at an economic life for the Amazon variety of cocoa and Date palm respectively. Farmers are no longer prepared to lose money as a result of neglect to cut down old trees. They are keen to know when to cut down old trees. The basic concept of this model is based on the optimum productive age. This is the point where the expected net returns from the present trees drop so low that it becomes profitable to replace the trees.

The objectives of the study

The objectives of the study are to:

I. determine the appropriate optimum replacement age of oil palm in the study area;
II. determine appropriate model for the replacement of the old oil palm trees;
III. determine when the economic returns justify the replacement of the old oil palm trees.

Methodology

Kogi State of Nigeria was chosen for the study. The area was chosen because it has oil palm production as one of its major industries and has participated in oil palm product trade in the 1960s and up to now, oil palm production is still being carried out (Agboola, 1979; Idachaba, 2005). The State is located between latitudes $6^0 30^1$North and $8^0 48^1$North and Longitudes $5^0 23^1$East and $7^0 48^1$East. It covers a land area of 30, 354.74 square kilometers (Km^2). Data for the study were collected from the Nigerian Institute for Oil Palm Research, NIFOR, Acharu sub-station and NIFOR Headquarters, Benin City. It was a time series data for about forty years.

The Optimum Replacement Model

The basic concept of this model is based on the optimum replacement age. This is the "point where the expected net returns from the present trees drop so low that it becomes profitable to replace the trees". The approach of this study was that of maximizing the entire future stream of net earnings from the existing enterprise. The approach requires that at the point of optimum replacement age, the anticipated annual net revenue from the present enterprise (Plots of oil palm) be equal to the amortized present value of the net revenue of the incoming enterprise (plots of oil palm). This approach implies non-replacement decision when the anticipated annual net present value of the net revenue of the existing enterprise is greater than the amortized present value of the net revenue of the incoming plot. A replacement decision is taken when the latter is greater than the former.

$NR_n = Y_n - a_{n-1}{}^i - b^n - c_n$ ..... (1)

Where NR_n = Net Revenue (₦)

Y_n = Gross Revenue (N)

an – 1i = Interest on the unpaid balance of the establishment cost at the beginning ofthe year or end of the previous year. (N)

bn = Annual maintenance cost (₦)

c_n = Planting cost (₦)

$$Pv\ of\ NR_n = \frac{1}{(1+r)^n}\ (NR_n) \text{.....(2)}$$

Where PV = Present value (N)

r = discount rate (%)

n = nth year

The amortized present value of the net revenue was obtained by accumulating value of the net revenue. This is represented thus:

$$NR_n = \sum_{t=0}^{n} \frac{NR_n}{(1+r)^n} \text{ ..... (3)}$$

Accumulated Present Value (APV) of is therefore the expression on the right side of equation (3) multiplied by the amortization factor:

$$\frac{1-V}{1-V^t}$$

$$Where\ V = \frac{1}{(1+r)}\ and$$

$$t = number\ of\ years$$

$$We\ now\ obtain,\ ANR_n = \left[\sum_{t-o}^{n} \frac{NR_n}{(1+r)^n}\right]\left[\frac{1-V}{1-V^t}\right]$$

Decision to replace therefore is $ANR_n \geq NR_{n+1}$

Results and Discussion

Cost constitutes the expense incurred while trying to produce oil palm products. This could be the cost of land acquisition, land preparation, seedlings, fertilizers, taxes, cutlassing, running/maintenance, and so on that are incurred in order to produce oil palm products. The cost of land preparation and planting at wage rate of ₦300.00/manday was ₦69, 452.70 while the material component cost for land preparation and planting was ₦57, 600.00 per hectare per year. Cutlassing 1st to 4th year was ₦76, 800.00, the 5th year onward was ₦43, 200.00 per hectare per year. Pruning (dead fronds, epiphytes, etc) up to 10th year was ₦4, 800.00 per hectare per year and pruning after the 10th year onward was ₦3, 600.00 per hectare per year. Fertilizer application was ₦ 4,800.00/ha per annum. The oil palm plantation maintenance/running cost with cost of materials required for five years and above was found to be ₦260, 252.70 annually.

The oil palm comes into fruiting at the age of 4 years after planting. The initial yield was 3.50 tons per hectare per year. The yield increases and reaching a peak in the 14th year with a peak yield of 13.50 tons/ha per year after which it eventually decline. This shows that the yield of oil palm is affected by the law of diminishing returns or diminishing marginal products. Whereas in Nigeria, the highest yield attained is 13.50 tons/ha/year, in Malaysia, a yield of 30.00 tons/ha/year has been achieved (Adegeye and Adegeye, 2000).

The study shows that farmers will be willing to cut down their old oil palm trees provided they are well informed at what age the old trees become uneconomical to remain on the farm. Old palms are usually too tall with impaired productivity. Tall palms have to be climbed which is arduous and risky. The fruits have to be harvested and sometimes there could be snakes on the oil palm. Besides, most oil palm farmers have no knowledge of the optimum production period of their palms, so, they allow them to produce fruits until they die on their own (Ikheloa and Nwawe, 2007; Ukwuteno, 2011). More so, as farmers in the study area have not made conscious attempt at new planting in recent years but have relied on old palms and naturally dispersed seeds for growth and production.This affects the production potential of the industry. The solution to the problem of over-aged palms is to replace them with new ones.

In the study area, farmers are unwilling to cut down old oil palm trees because there has been no government intervention either by way of subsidy or loan regime that will favour or encourage farmers to do so. The farmer will lose income if he fails to replace the existing plot with a new one at the optimum replacement age. Without government policy on the issue, farmers in the area may fail to effect replacement as they do not carry out day to day management activities on the existing enterprise except to harvest whatever the enterprise can give in a year.

Table 1 shows the constructed profit maximization replacement period for oil palm in Nigeria. The various calculations were based on the assumption that market prices are taken to reflect real resource value. Thus, the producer price is ₦10.00/kg of fresh fruit bunch (ffb), the wage rate is ₦300.00/manday and the discount rate is 10 percent. The optimum replacement age of oil palm based on this is 35 years. If replacement is not carried say early in the 35th year but later in the 35th year, the farmer stands to lose the difference between the amortized present value of the net revenue (APV.NRn column 7) and the anticipated net revenue in year t+1, column 8. This becomes cumulative the longer he fails to replace, (fig. 1). For example, if he fails to replace early in the 35th year but later in the 35th year, he will lose ₦906.50 and if the replacement is carried out in the 36th year, the farmer will lose₦ 906.50plus ₦1, 865.80, this gives ₦2772.30/ha.(Table 1 and Fig. 1).

Conclusion and Recommendations

The study examined the issues involved in oil palm production in Kogi State, Nigeria. The major constraints being that of finance and government policy direction. Oil palm production is a profitable venture which must be encouraged and at the same time it is capital intensive. The current *laissez faire* attitude by government toward oil palm production cannot lead to the desired transformation in the oil palm industry. If countries like Malaysia, Indonesia and other nations could cause economic well-being of their countries through oil palm, with the nature endowment of resources in Nigeria, oil palm could become a rallying point at causing economic revolution in Nigeria's rural economy.

Table 1: The Optimum Replacement Age of Oil Palm (Tenera) in Kogi State: Acharu Oil Palm Plantation, NIFOR Substation.

Age	Net Revenue NR_t	Discount Factor DF	Present Value of Net Revenue PVNR	Accumulated Present Value of Net Revenue ACC.NR	Amortized Factor A.F. $\left(\frac{1-v}{1-v^t}\right)$	Amortized Present Value of Net Revenue APV.NR	NR_{t+1}
0	-69452.70	1.0000	-69452.70	-69452.70	1.0000	-69452.70	-57600.00
1	-57600.00	0.9091	-52364.16	-121816.86	1.1000	-133998.55	-43200.00
2	-43200.00	0.8264	-35700.48	-157517.34	0.5238	-82507.58	-32400.00
3	-32400.00	0.7513	-24342.12	181859.46	0.3655	-66469.63	2600.00
4	2600.00	0.6830	1775.80	-18083.66	0.2868	-51647.99	31100.00
5	31100.00	0.6209	19304.99	-160773.67	0.2398	-38553.53	32271.87
6	32271.87	0.5645	18217.47	-142556.20	0.2087	-29751.48	39212.50
7	39212.50	0.5132	20123.86	-122432.34	0.1867	-22858.12	61386.12
8	61386.12	0.4665	28636.62	-93795.72	0.1704	-15982.79	90702.87
9	90702.87	0.4241	38467.09	-55328.63	0.1578	-8730.86	92927.62
10	92927.62	0.3855	35823.60	-19505.03	0.1479	-2884.79	91800.00
11	91800.00	0.3505	32175.90	12670.87	0.1400	1773.92	93300.00
12	93300.00	0.3186	29725.38	42396.25	0.1334	5655.66	85200.00
13	85200.00	0.2897	24682.44	67078.69	0.1280	8586.07	106800.00
14	106800.00	0.2633	28120.44	95199.13	0.1234	11747.57	106800.00
15	106800.00	0.2394	25567.92	120767.05	0.1195	14431.66	88200.00
16	88200.00	0.2176	19192.32	139959.37	0.1162	16263.28	100800.00
17	100800.00	0.1978	19938.24	159897.61	0.1133	18116.40	82500.00
18	82500.00	0.1799	14841.75	174739.36	0.1108	19361.12	99600.00
19	99600.00	0.1635	16284.60	191023.96	0.1087	20764.30	88200.00
20	88200.00	0.1486	13106.52	204130.48	0.1068	21801.14	82800.00
21	82800.00	0.1351	11186.28	215316.76	0.1051	22629.79	88500.00
22	88500.00	0.1228	10867.80	226184.56	0.1036	23432.72	94500.00
23	94500.00	0.1117	10555.65	236740.21	0.1023	24218.52	94200.00
24	94200.00	0.1015	9561.30	246301.51	0.1012	24925.71	90600.00
25	90600.00	0.0923	8362.38	254663.89	0.1001	25491.86	58300.00
26	58300.00	0.0839	4891.37	259555.26	0.0992	25747.88	48700.00
27	48700.00	0.0763	3715.81	263271.07	0.0984	25905.87	50500.00
28	50500.00	0.0693	3499.65	266770.72	0.0977	26063.50	44500.00
29	44500.00	0.0630	2803.50	269574.22	0.0970	26148.70	56200.00
30	56200.00	0.0573	3220.26	272794.48	0.0964	26297.39	42500.00
31	42500.00	0.0521	2214.25	275008.73	0.0959	26373.34	49700.00
32	49700.00	0.0474	2355.78	277364.51	0.0954	26460.57	57800.00
33	57800.00	0.0431	2491.18	279855.69	0.0950	26586.29	32800.00
34	32800.00	0.0391	1282.48	281138.17	0.0946	26595.67	35200.00
35	35200.00	0.0356	1253.12	282391.29	0.0943	26629.50	25723.00
36	25723.00	0.0324	833.43	283224.72	0.0939	26594.80	24729.00
37	24729.00	0.0294	727.03	283951.75	0.0937	26606.28	17217.00
38	17217.00	0.0267	459.69	284411.44	0.0934	26564.04	5522.00
39	5522.00	0.0243	134.18	284545.62	0.0932	26519.65	5705.00
40	5705.00	0.0221	126.08	284671.70	0.0930	26474.47	

Source: Constructed from Field Survey Data, 2008

Producer Price, ₦10.00/Kg fresh fruit bunch (ffb),Wage rate, ₦300.00/Manday, Discount rate, 10%.

This can be achieved through commitment by government and adequate sensitization of the rural populace on the need to cut down over-aged oil palm trees for replacement at the age of 35 years. It is important that:

I. every household that own or has land should plant at least one hectare of oil palm. This will help to alleviate poverty of rural farmers.

II. the idea of relying on the naturally dispersed seeds for the transformation of oil palm can no longer sustain the industry. There is a needfor conscious effort at new planting and replanting of oil palm plantations with improved cultivars/seeds/seedlings.

III. oil palm should be cut down at the age of 35 years. This will give opportunity for its replacement without undue interference with the flow of output of oil palm products.

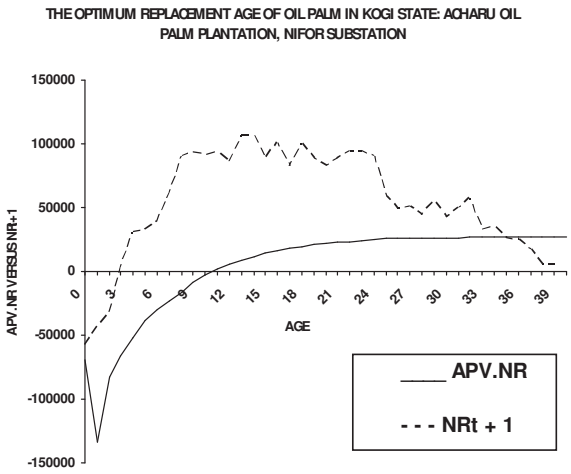

Fig: 1: Optimum Replacement Period

References

Adegeye, A. J. and A.O. Adegeye (2000). Technical and Economic Information in Agriculture (The Oil Palm Elaeis guineensis) in Nigeria Agricultural Development Studies 1(2): 140 – 156

Agboola, S.A. (1979). An Agricultural Atlas of Nigeria. Oxford University Press. Pp115 – 134.

Centre for Tropical Agriculture (CTA, 1998). The Tropical Agriculturist. Oil Palm. Macmillan Publishers

Hartley, C.W.S. (1988). The Origin and Development of the Oil Palm Industry in the Oil Palm (Elaeis guineensis Jacq) 3rd Edition Pp. 1 – 43.

Ibe, D.G. and F.I. Nweke (1985). Budgetary Requirements for Increased Palm Oil Production in South-Eastern Nigeria. Farm Operations Department of Agric. Economics, University of Nigeria, Nsukka. Proceedings of National Conference. National Association of Agricultural Economists, University of Nigeria, Nsukka. Pp17 – 20

.Idachaba, F.S. (2005). Text of Convocation Lecture Delivered at the Kogi State University, Anyigba.

Ikheloa, M. and C.N. Nwawe (2007). Analysis of Optimum Replacement Age of Date Palm in Nigeria: A Case Study of NIFOR Substation, Dutse, Jigawa State, Nigeria. Proceedings of the 41st Conference of the Agricultural Society of Nigeria (ASN) Samaru, Zaria. Pp494 – 499

Izeke, J.E. (1983). Economic Evaluation of the World Bank Assisted Cocoa Project in Nigeria. A Ph.D Agricultural Economics Thesis submitted to the Faculty of Agriculture and Forestry, University of Ibadan, Nigeria. Pp57 – 61

Keu, S.T. (2001). Review of Previous Similar Studies on the Environmental Impacts of Oil Palm Plantation Cultivation on People, Soil, Water and Forest Ecosystems. www.csir.org.gh/opri.html

Khera, H.S. (1976). Is there a need for National and International Control Schemes for Palm Oil? The International Development in Palm Oil. The Proceedings of the Malaysian International Symposium on palm oil processing and marketing held in Kuala Lumpur. Earp, D.A. and Newall, W. (Eds). Pp 491 – 1507.

Kochhar, S.L. (1976). Tropical Crops – A Textbook of Economic Botany. Macmillan International College Edition. Pp164 – 167

National Research Development Corporation (NRDC,2003).Palm Oil: A Government of India Enterprise 20-22. Zamroodpur Community Center Kailash Colony Extension, NewDelhi 110048,India. www.nrdcindia.com

Opeke, L.K. (1992). Tropical Tree Crops: Spectrum Books Ltd, Ibadan, Owerri, Kaduna, Lagos. Woye and Sons (Nig) Ltd, Ilorin. Pp253 – 274

Ukwuteno, S.O. (2011). Economics of Small-scale Oil Palm Production in Kogi State, Nigeria. A Ph.D Thesis Presented to the Dept of Agricultural Economics, University of Nigeria, Nsukka, Nigeria

United States Department of Agriculture (USDA, 2000). Oil Palm Production, Consumption, Exports and Imports Statistics

Usoro, E.J. (1974). The Nigerian oil Palm Industry. (Government Policy and Export Production 1906 – 1965, Ibadan University Press. Pp130 – 140.